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Attorney Docket No.: **10525/003001**

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Assistant Commissioner for Patents
Washington, DC 20231

Presented for filing is a new original patent application of:

Applicant:	ANTHONY M. LOVELL, SYLVAN CLEBSCH AND GREG COCKROFT
Title:	EFFICIENT TRANSMISSION OF DATA TO MULTIPLE NETWORK NODES

Enclosed are the following papers, including those required to receive a filing date under 37 CFR §1.53(b):

	Pages
Specification	9
Claims	14
Abstract	1
Signed Declaration	[To Be Filed At A Later Date]
Drawing(s)	6

Enclosures:

- Postcard.

This application is entitled to small entity status. A small entity statement will be filed at a later date.

"EXPRESS MAIL" Mailing Label Number EL182580908US

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Lisa G Gray

Lisa G Gray

Basic filing fee	380.00
Total claims in excess of 20 times $9.00	423.00
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Fee for multiple dependent claims	0.00
Total filing fee:	$ 920.00

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Respectfully submitted,

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Enclosures

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: **EFFICIENT TRANSMISSION OF DATA TO MULTIPLE NETWORK NODES**

APPLICANT: **ANTHONY M. LOVELL, SYLVAN CLEBSCH AND GREG COCKROFT**

"EXPRESS MAIL" Mailing Label Number EL 182580908 US

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Lisa G Gray

Lisa G Gray

EFFICIENT TRANSMISSION OF DATA TO MULTIPLE NETWORK NODES

Background of the Invention

The growth of the Internet has spurred the development of many new programs and services that permit two-way communication between more than two users at the same time. Such communication may be in the form of typed messages, for example in the internet relay chat (IRC) service, or as voice or video transmitted over the network.

Typically such programs and services use the concept of a "channel" to refer to a set of network nodes that are in mutual communication with each other. When a node subscribes to a channel, it receives copies of all of the messages that are transmitted over the channel. Programs and services using channels must therefore provide a mechanism for distributing packets issuing from one node on the channel to all of the other nodes on the channel.

Two general models have been heretofore applied in this regard. In a peer-to-peer model each node is responsible for sending a copy of each packet to all of the other nodes on the channel. This model is limited, however, by the bandwidth of the node's network connection. For example, if the node was connected to a network by a slow dial-up connection and the node were to transmit to more than a few other nodes on the network, this could produce excessive delays. Delays are especially significant for real time audio or video communication, since they can reduce the quality of the audio or video signal received by other nodes.

An alternative to the peer-to-peer model is the client-server model. In the client server model, data communicated between the various nodes subscribing to a channel (referred to as "clients") are always directed

through a dedicated intermediary computer known as the "server." In the simplest case, the server acts as a reflector of the data packets received from clients. Each packet received at the server is copied, with a copy transmitted to every other client on the channel.

Alternatively, servers may combine data received from multiple nodes (e.g. by mixing simultaneously received audio signals), and transmit the combined data to the clients on the channel.

Because the server is dedicated to retransmission of data from a large number of clients, its bandwidth may be underutilized if it is not operating at full capacity.

Summary of the Invention

The present invention provides an improved method, system, and computer program product for providing communication among multiple nodes on a network.

In one aspect, the invention is a method for transmitting a data block over a network from a first sending node to a first set of recipient nodes, including, in the first sending node, a) dividing the first set of recipient nodes into a subset of selected nodes, selected according to scoring criteria associated with each recipient node, and a subset of unselected nodes, b) assigning at least one of the unselected nodes to at least one selected node according to scoring criteria associated with the respective selected nodes, and c) transmitting to each selected node a packet including the data block and a list of the nodes assigned to the selected node.

In another aspect, the invention is a method for transmitting a data block over a network from a first sending node to a first set of recipient nodes, including, the steps of, in a selected node, a) receiving from the first sending node the packet including the data block and a

list of assigned nodes, b) dividing the list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes, c) re-assigning at least one of the unselected assigned nodes to at least one selected assigned node according to the scoring criteria associated with respective selected assigned nodes, and d) transmitting to each selected assigned node a packet including the data block and a list of the nodes re-assigned to the selected assigned node.

It is therefore an advantage of the invention to provide a method and system for enabling a node in a data network, having a low effective bandwidth, to transmit data to a large number of other nodes in the network, without excessive delay. It is a further advantage of the invention to provide a method and system for enabling a node in a data network to transmit data to a large number of other nodes in the network, without the use of a dedicated server.

These, and other advantages of the present invention, are fully described in the following detailed description of a preferred embodiment, and in the claims.

Brief Description of the Drawings

Figure 1 shows a network for performing an embodiment of the invention.

Figure 2 is a schematic diagram of a packet for transmitting data on a network.

Figure 3 is a schematic diagram showing channel lists in a node.

Figure 4 is a flowchart showing steps taken by an embodiment of the invention.

Figure 5 is a schematic diagram of a packet used by an embodiment of the invention.

Figure 6 is a flowchart showing steps taken by an embodiment of the invention.

Description of the Preferred Embodiments

Figure 1 shows a computer network 100, such as the Internet, or a local area network, in which multiple nodes 110a-110h are connected to the network using a set of heterogeneous communication interfaces 120a-120h. Examples of such communication interfaces include 28.8 kilobaud modems, ISDN lines, T1 lines and T3 lines. Each communication interface 120a-120h has a characteristic bandwidth, measured in bits per second. A node may include any programmed electronic device capable of communicating data over a network, such as a computer workstation, a cable television interface, a personal communications system (PCS) device, and the like.

Nodes communicate by transmitting packets 200 via the network. As shown in Figure 2, each packet includes a header 210, that contains addressing information, such as an internet protocol (IP) address, and a payload 220 that contains the data to be communicated to the recipient.

Referring to Figure 3, each node on the network may, at a given time, be subscribed to one or more channels. Each node 110 maintains a channel list for each channel to which it is subscribed. A channel list 300 includes a channel ID 310, which uniquely identifies the channel, along with a set of node IDs 320, which identify every other node subscribed to the channel. Associated with each node address in the channel list 300 is an effective bandwidth value 330, a number representing the effective bandwidth of the communications interface for that node.

Channel subscription (i.e. the adding or subtracting of nodes from a channel) may be handled using any conventional method. For example, a dedicated subscription

server may be used to subscribe and unsubscribe nodes on a channel. A new node could be added to the channel by transmitting a request to the server. The server, in turn, would inform all existing channel subscribers of the identity of the new member, which would update their respective channel lists 300 accordingly. Alternatively, one of the channel members could be selected to serve as the subscription server through a negotiation process between channel members.

When a node subscribes to a channel, it provides the subscription server with information about itself, including its effective bandwidth, which is retransmitted to the other channel subscribers to permit each subscribing node 110 to maintain an up-to-date channel list 300.

In general, the effective bandwidth of a node is the nominal bandwidth of the node's communications interface. However, under some circumstances, a node may provide an effective bandwidth value that is less than the nominal bandwidth of its communications interface when it cannot allocate all of its bandwidth for communication on a given channel. For example, the node might already be subscribed to other communication channels, or the node may be engaged in non-channel communication.

The transmission of a data packet from a sending node to other nodes in a channel will now be described. First, the sending node 110 determines the value of MAXCHAN, the maximum number of simultaneous transmission streams that it can support (step 500). MAXCHAN may be a function of the node's effective bandwidth, or may be empirically determined.

Next, the sending node 110 examines the channel list 300 to determine whether there are more than MAXCHAN nodes on the channel (other than the sending node) (step 510). If

there are not more than MAXCHAN other nodes on the channel list 300, the sending node sends packets containing the data block directly to each of the nodes on the channel list (step 520). In a preferred embodiment, the packets are sent approximately simultaneously.

If there are more than MAXCHAN other nodes on the channel list, the sending node selects the MAXCHAN number of nodes on the channel list having the highest effective bandwidths (step 530).

Next, the sending node computes, for each of the selected nodes, a fair share value (step 540). This value is computed by taking the ratio of the effective bandwidth 330 for a given selected node to the sum of the effective bandwidths 330 for all of the selected nodes.

Next, the sending node assigns each of the remaining (unselected) nodes to one of the selected nodes, in approximate proportion to the fair share values computed for each selected node (step 550). In an alternative embodiment, the sending node could assign only a portion of the unselected nodes, according to a prioritization scheme, if the node determines that the number of unselected nodes exceeds an operational limit.

Next, the sending node sends a packet to each of the selected nodes (step 560). In a preferred embodiment, the packets are sent approximately simultaneously. Referring to Figure 5, the header 210 of each packet is addressed to one of the selected nodes, while the payload portion 220 of each packet includes node ID of the sending node (identified as the originator of the data block) 225 the data block 230, and a list 240 of the nodes assigned to the node to which the packet is addressed.

Referring now to Figure 6, when a packet from a sending node arrives at one of the selected nodes, it is

received (step 600), and the originator node ID 225 and data block 230 are extracted (step 610). This information can then be used at the receiving node by other processes. For example, if the data block 230 includes audio data, the data block 230 could be used to generate audio outputs at the selected node.

The receiving node then determines its MAXCHAN value, (step 620), and compares it to the number of nodes on the list of assigned nodes in the packet received from the sending node (step 630). If the number of nodes in the list is not greater than MAXCHAN, the receiving node transmits packets containing the data block 230 to each of the assigned nodes (step 640).

If the list of assigned nodes is longer than MAXCHAN, the following steps are performed. The receiving node selects the MAXCHAN nodes from the assigned nodes list having the greatest bandwidth (step 650), and then calculates a fair share value for each of the selected nodes (step 660). It then re-assigns each of the unselected assigned nodes from the list to one of the selected nodes from the list, in approximate proportion to the fair share values of each selected node (step 670). (In an alternative embodiment, the receiving node could re-assign only a portion of the unselected assigned nodes, according to a prioritization scheme, if the receiving node determines that the number of unselected assigned nodes exceeds an operational limit.) The receiving node then transmits a packet to each of the selected nodes, containing the originator node ID 225, the data block 230, plus a list of the nodes re-assigned to the node to which the packet is addressed (step 680). Each of the nodes receiving these packets processes them in a similar fashion, by executing the steps beginning at step 600. This process continues

until the data block has been distributed to all of the nodes in the channel.

In this way, the invention advantageously provides a method for distributing packets to a large number of recipient nodes on a channel, without effective limitation from the effective bandwidth of the sending node, and without using a dedicated server.

In alternative embodiments, criteria other than, or in addition to, effective bandwidth, may be used by a sending node to select recipient nodes.

In one alternative embodiment, the channel list 300 of a given node includes information identifying the latency (average delay between transmission and reception of a packet) associated with transmissions from the given node to each other node in the channel. These values are computed by the given node and updated periodically by sending test messages to the other nodes on the channel and calculating the time to receive a response. In this embodiment, nodes are selected by assigning to each a score, based on a weighted difference of the effective bandwidth and the latency of the node, and then selecting the nodes with the highest scores. Similarly, unselected nodes are assigned to selected nodes in approximate proportion to their scores, rather than their effective bandwidths.

In another embodiment, node scores are computed as a function of the effective bandwidth, latency, and recency. Recency refers to the amount of time since a data block was received that was initially sent (i.e. not merely re-transmitted as described above) by a given node. Such a function could give greater scores to nodes with lower recency values, thus making it more likely that nodes from which packets were recently received will be among the first the receive outgoing data.

In another alternative embodiment, a given unselected node may be assigned to more than one of the selected nodes, thus providing a redundant route between the sending node and the ultimate recipient for transmission of a given data block. If this resulted in multiple copies of the data block arriving at the ultimate recipient node, the ultimate recipient node would simply ignore the subsequent copies. This could be done, for example, by assigning each data block a serial number in the sending node, and comparing the serial number of each data block received by the ultimate recipient node to a list of serial numbers already received from the sending node. This embodiment would be useful where the reliability of different transmission paths in the network varies or is unknown.

The invention described herein may be implemented in software or in hardware. In particular, the invention may be implemented by programming a computer in each node to perform the steps necessary to carry out the method described herein. Programming codes for carrying such steps may be placed on a computer readable medium for convenient transport and storage.

What is claimed is:

1. A method for transmitting a data block over a network from a first sending node to a first set of recipient nodes, comprising:

in the first sending node:

dividing the first set of recipient nodes into a subset of selected nodes, selected according to scoring criteria associated with each recipient node, and a subset of unselected nodes;

assigning at least one of the unselected nodes to at least one selected node according to scoring criteria associated with the respective selected nodes;

transmitting to each selected node a packet including the data block and a first list of the nodes assigned to the selected node.

2. The method of claim 1, wherein each unselected node is assigned to at least one selected node.

3. The method of claim 1, further comprising:

in at least one recipient node:

receiving from the first sending node the packet including the data block and the first list of assigned nodes;

dividing the first list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assigning each of the unselected assigned nodes to at least one selected assigned node

according to the scoring criteria associated with the respective selected assigned nodes;

transmitting to each selected assigned node a packet including the data block and a list of the nodes re-assigned to the selected assigned node.

4. The method of claim 3, wherein the at least one recipient node includes at least two recipient nodes.

5. The method of claim 3, further comprising, in the first selected node, generating a user discernable output reflecting information in the data block.

6. The method of claim 1, wherein the scoring criteria for at least one recipient node includes the effective bandwidth of that node.

7. The method of claim 1, wherein the scoring criteria for at least one recipient node includes the latency between the first sending node and that recipient node.

8. The method of claim 1, wherein the scoring criteria for at least one recipient node includes the amount of time since a packet from that recipient node was received by the first sending node.

9. The method of claim 1, wherein the data block contains audio data.

10. The method of claim 1, wherein the data block contains video data.

11. The method of claim 2, wherein each unselected node is assigned to only one selected node.

12. The method of claim 1, further comprising:

in a second sending node, which is also in the first set of recipient nodes:

dividing a second set of recipient nodes into a subset of selected nodes, selected according to scoring criteria associated with each recipient node, and a subset of unselected nodes;

assigning each of the unselected nodes from the second set of recipient nodes to at least one selected node from the second set of recipient nodes according to scoring criteria associated with the respective selected nodes;

transmitting to each selected node from the second set of recipient nodes a packet including the data block and a second list of the nodes assigned to the selected node.

13. The method of claim 12, further comprising:

in a second selected node:

receiving from the second sending node the packet including the data block and the second list of assigned nodes;

dividing the second list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assigning each of the unselected assigned nodes from the second list of assigned nodes to at least one selected assigned node from the second

list of assigned nodes according to the scoring criteria associated with the respective selected assigned nodes;

transmitting to each selected assigned node from the second list of assigned nodes a packet including the data block and a list of the nodes re-assigned to that node.

14. A method for transmitting a data block over a network from a first sending node to a first set of recipient nodes, comprising:

in at least one selected node in the first set of recipient nodes:

receiving from the sending node the packet including the data block and a list of assigned nodes;

dividing the list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assigning at least one of the unselected assigned nodes to at least one selected assigned node according to the scoring criteria associated with the respective selected assigned nodes;

transmitting to each selected assigned node a packet including the data block and a list of the nodes re-assigned to the selected assigned node.

15. The method of claim 14, wherein each unselected assigned node is re-assigned to at least one selected assigned node.

16. The method of claim 14, wherein the at least one selected node includes at least two selected nodes.

17. The method of claim 14, further comprising, in at least two of the first set of recipient nodes, generating a user discernable output reflecting information in the data block.

18. The method of claim 14, wherein the scoring criteria for at least one of the nodes on the list of assigned nodes includes the effective bandwidth of that node.

19. The method of claim 14, wherein the scoring criteria for at least one of the nodes on the list of assigned nodes includes the latency between the assigned node and the selected node.

20. The method of claim 14, wherein the scoring criteria for at least one of the nodes on the list of assigned nodes includes the amount of time since a packet from the assigned node was received by the selected node.

21. The method of claim 14, wherein the data block contains audio data.

22. The method of claim 14, wherein the data block contains video data.

23. The method of claim 15, wherein each unselected assigned node is re-assigned to only one selected assigned node.

24. A computer program product residing on a computer readable medium comprising instructions for causing a particular network node, connected to a network having a plurality of network nodes, to:

create a first set of recipient nodes from among the plurality of network nodes;

divide the first set of recipient nodes into a subset of selected nodes, selected according to scoring criteria associated with each recipient node, and a subset of unselected nodes;

assign at least one of the unselected nodes to at least one selected node according to scoring criteria associated with the respective selected nodes;

transmit to each selected node a packet including a data block and a list of the nodes assigned to the selected node.

25. The product of claim 24, further comprising instructions for causing the particular network node to assign each of the unselected nodes to at least one selected node.

26. The product of claim 24, further comprising instructions for causing the particular network node to:

receive from one of the network nodes a packet including a data block and a list of assigned nodes;

divide the received list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assign each of the unselected assigned nodes to at least one selected assigned node according to the scoring

criteria associated with the respective selected assigned nodes;

transmit to each selected assigned node a packet including the received data block and a list of the nodes re-assigned to the selected assigned node.

27. The product of claim 26, further comprising instructions for causing the particular network node to generate a user discernable output reflecting information in the data block contained in the received packet.

28. The product of claim 24, wherein the scoring criteria for at least one recipient node includes the effective bandwidth of that node.

29. The product of claim 24, wherein the scoring criteria for at least one recipient node includes the latency between the particular node and the recipient node.

30. The product of claim 24, wherein the scoring criteria for at least one recipient node includes the amount of time since a packet from the recipient node was received by the particular node.

31. The product of claim 24, wherein the transmitted data block contains audio data.

32. The product of claim 24, wherein the transmitted data block contains video data.

33. The product of claim 25, wherein the instructions for causing the particular node to assign each unselected node to at least one selected node are

instructions for causing the particular node to assign each unselected node to only one selected node.

34. A computer program product residing on a computer readable medium comprising instructions for causing a particular network node, connected to a network having a plurality of network nodes, to:

receive from one of the network nodes a packet including a data block and a list of assigned nodes;

divide the list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assign at least one of the unselected assigned nodes to at least one selected assigned node according to the scoring criteria associated with respective selected assigned nodes;

transmit to each selected assigned node a packet including the received data block and a list of the nodes re-assigned to the selected assigned node.

35. The product of claim 34, further comprising instructions for causing the particular network node to re-assign each of the unselected assigned nodes to at least one selected assigned node.

36. The product of claim 34, further comprising instructions for causing the first network node to generate a user discernable output reflecting information in the data block contained in the received packet.

37. The product of claim 34, wherein the scoring criteria for at least one node on the list of assigned nodes includes the effective bandwidth of the node.

38. The product of claim 34, wherein the scoring criteria for at least one node on the list of assigned nodes includes the latency between that node and the particular network node.

39. The product of claim 34, wherein the scoring criteria for at least one node on the list of assigned nodes includes the amount of time since a packet from that node was received by the particular network node.

40. The product of claim 34, wherein the transmitted data block contains audio data.

41. The product of claim 34, wherein the transmitted data block contains video data.

42. The product of claim 35, wherein the instructions for causing the particular network node to re-assign each unselected assigned node to at least one selected assigned node cause the particular network node to re-assign each unselected assigned node to only one selected assigned node.

43. A system for transmitting data comprising:

a data network;

a plurality of network nodes, including at least one sending node;

wherein each sending node is programmed to:

create a first set of recipient nodes from among the plurality of network nodes;

divide the first set of recipient nodes into a subset of selected nodes, selected according to scoring criteria associated with each recipient node, and a subset of unselected nodes;

assign at least one of the unselected nodes to at least one selected node according to scoring criteria associated with the respective selected nodes;

transmit to each selected node a packet including a data block and a list of the nodes assigned to the selected node.

44. The system of claim 43, wherein each sending node is programmed to assign each of the unselected nodes to at least one selected node.

45. The system of claim 43, wherein at least one of the plurality of network nodes is programmed to:

receive from one of the network nodes a packet including a data block and a list of assigned nodes;

divide the list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assign each of the unselected assigned nodes to at least one selected assigned node according to the scoring criteria associated with respective selected assigned nodes;

transmit to each selected assigned node a packet including the received data block and a list of the nodes re-assigned to the selected assigned node.

46. The system of claim 45, wherein the at least one of the plurality of network nodes includes at least two network nodes.

47. The system of claim 43, wherein at least two of the network nodes are programmed to generate a user discernable output reflecting information in the data block contained in the received packet.

48. The system of claim 43, wherein the scoring criteria for at least one recipient node includes the effective bandwidth of the node.

49. The system of claim 43, wherein the scoring criteria for at least one recipient node includes the latency between the sending node and the recipient node.

50. The system of claim 43, wherein the scoring criteria for at least one recipient node includes the amount of time since a packet from the recipient node was received by the sending node.

51. The system of claim 43, wherein the transmitted data block contains audio data.

52. The system of claim 43, wherein the transmitted data block contains video data.

53. The system of claim 43, wherein there are at least two sending nodes.

54. The system of claim 45, wherein the at least one of the plurality of network nodes includes at least one sending node.

55. The system of claim 44, wherein each of the sending nodes is programmed to assign each of the unselected nodes to only one selected node.

56. A system for transmitting data comprising:

a data network;

a plurality of network nodes;

wherein at least one particular node of the plurality of network nodes is programmed to:

receive from one of the network nodes a packet including a data block and a list of assigned nodes;

divide the list of assigned nodes into a subset of selected assigned nodes, selected according to scoring criteria associated with each assigned node, and a subset of unselected assigned nodes;

re-assign at least one of the unselected assigned nodes to at least one selected assigned node according to the scoring criteria associated with respective selected assigned nodes;

transmit to each selected assigned node a packet including the received data block and a list of the nodes re-assigned to the selected assigned node.

57. The system of claim 56, wherein the at least one particular node is programmed to re-assign each of the unselected assigned nodes to at least one selected assigned node.

58. The system of claim 56, wherein the at least one particular node includes at least two particular nodes.

59. The system of claim 56, wherein at least two of the network nodes are programmed to generate a user discernable output reflecting information in the data block contained in the received packet.

60. The system of claim 56, wherein the scoring criteria for at least one node from the list of assigned nodes includes the effective bandwidth of the node.

61. The system of claim 56, wherein the scoring criteria for at least one node from the list of assigned nodes includes the latency between the particular node and the assigned node.

62. The system of claim 56, wherein the scoring criteria for at least one node from the list of assigned nodes includes the amount of time since a packet from the assigned node was received by the particular node.

63. The system of claim 56, wherein the transmitted data block contains audio data.

64. The system of claim 56, wherein the transmitted data block contains video data.

65. The system of claim 56, wherein there are at least two sending nodes.

66. The system of claim 56, wherein the at least one particular node of the plurality of network nodes includes at least one sending node.

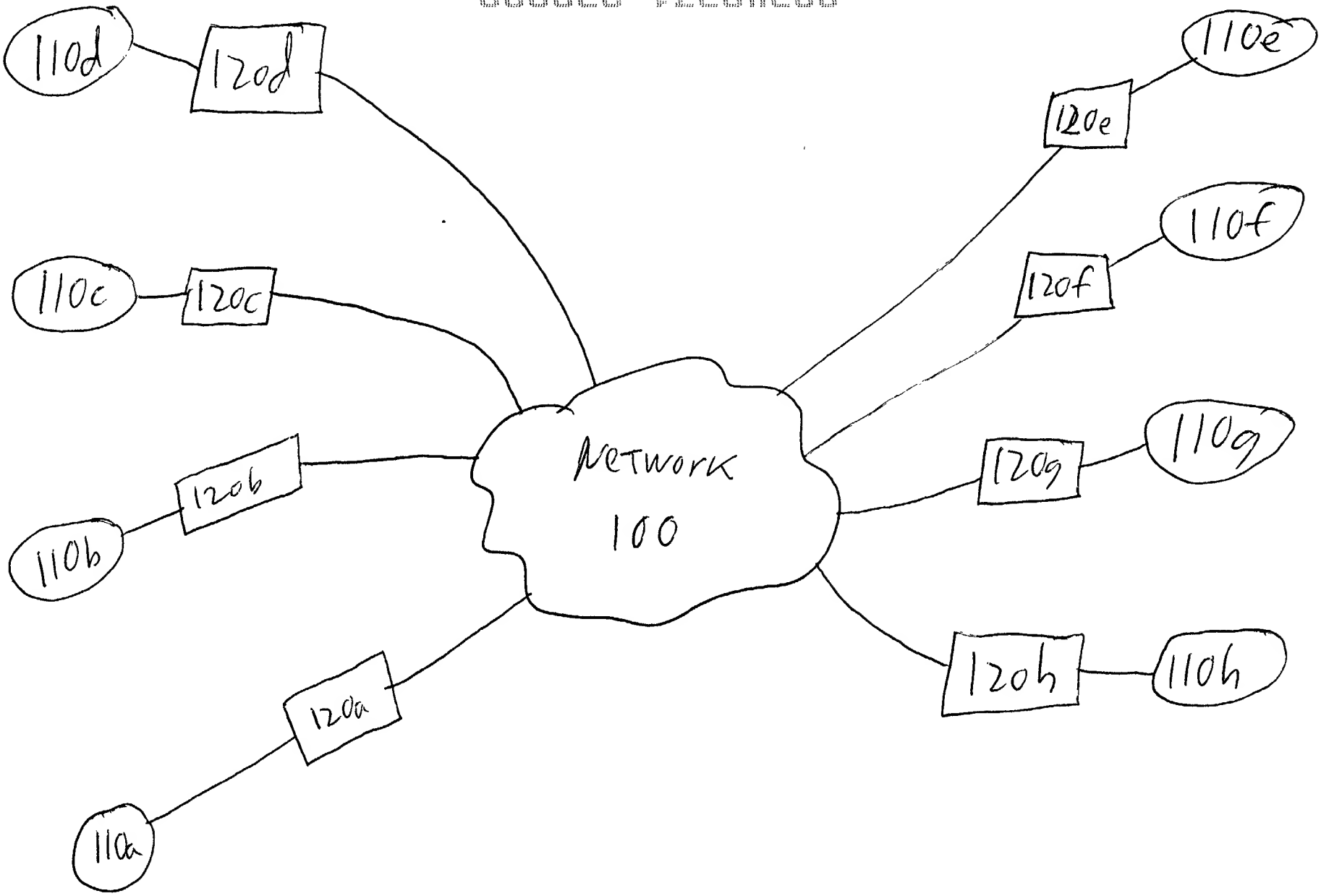
67. The system of claim 57, wherein the at least one particular node is programmed to re-assign each unselected assigned node to only one selected assigned node.

EFFICIENT TRANSMISSION OF DATA TO MULTIPLE NETWORK NODES

Abstract of the Disclosure

An improved method, system, and computer program product for efficient transmission of data to multiple network nodes is disclosed. A method for transmitting a data block over a network from a first sending node to a first set of recipient nodes, comprises, in the first sending node, a) dividing the first set of recipient nodes into a subset of selected nodes, selected according to scoring criteria associated with each recipient node, and a subset of unselected nodes, b) assigning at least one of the unselected nodes to at least one selected node according to scoring criteria associated with the respective selected nodes, c) transmitting to each selected node a packet including the data block and a list of the nodes assigned to the selected node.

350120.B11


110d
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110e
120e
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Network
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110g
120g
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120h
110h
110a

Figure 1

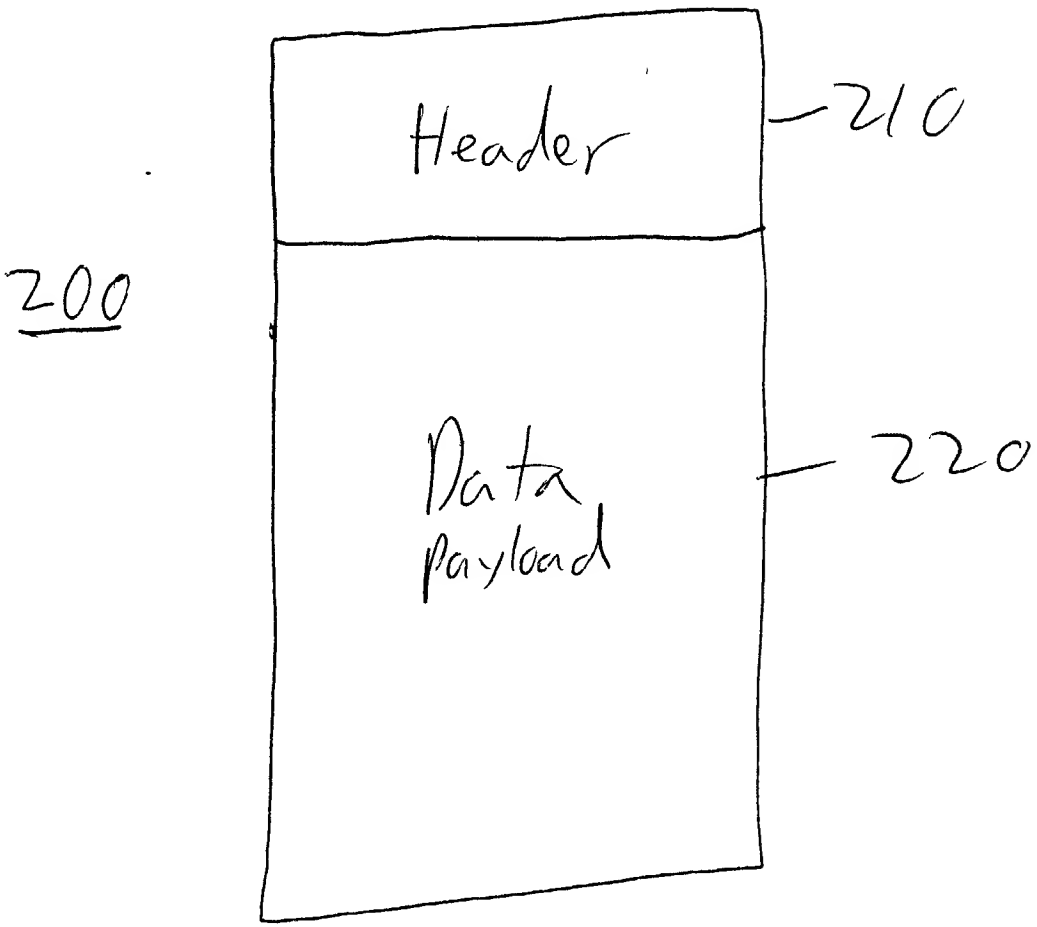
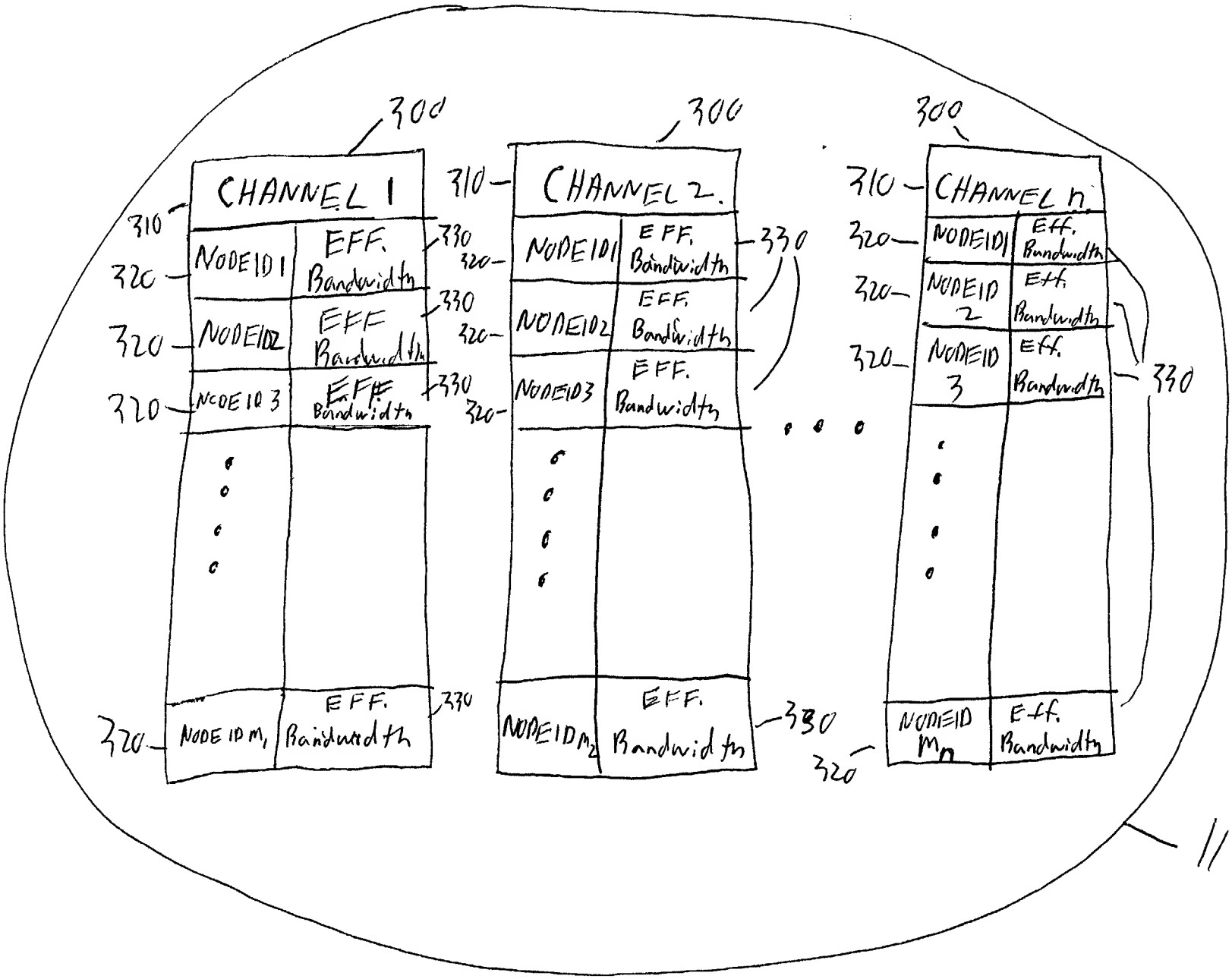


Figure 2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320
330
NODE ID 2
EFF Bandwidth
NODE ID 3
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300
CHANNEL 2.
NODE ID 1
EFF. Bandwidth
NODE ID 2
EFF. Bandwidth
NODE ID 3
EFF. Bandwidth
NODE ID M2
EFF. Bandwidth
300
CHANNEL n.
NODE ID 1
Eff. Bandwidth
NODE ID 2
Eff. Bandwidth
NODE ID 3
Eff. Bandwidth
NODE ID Mn
Eff. Bandwidth
110

Fig. 3

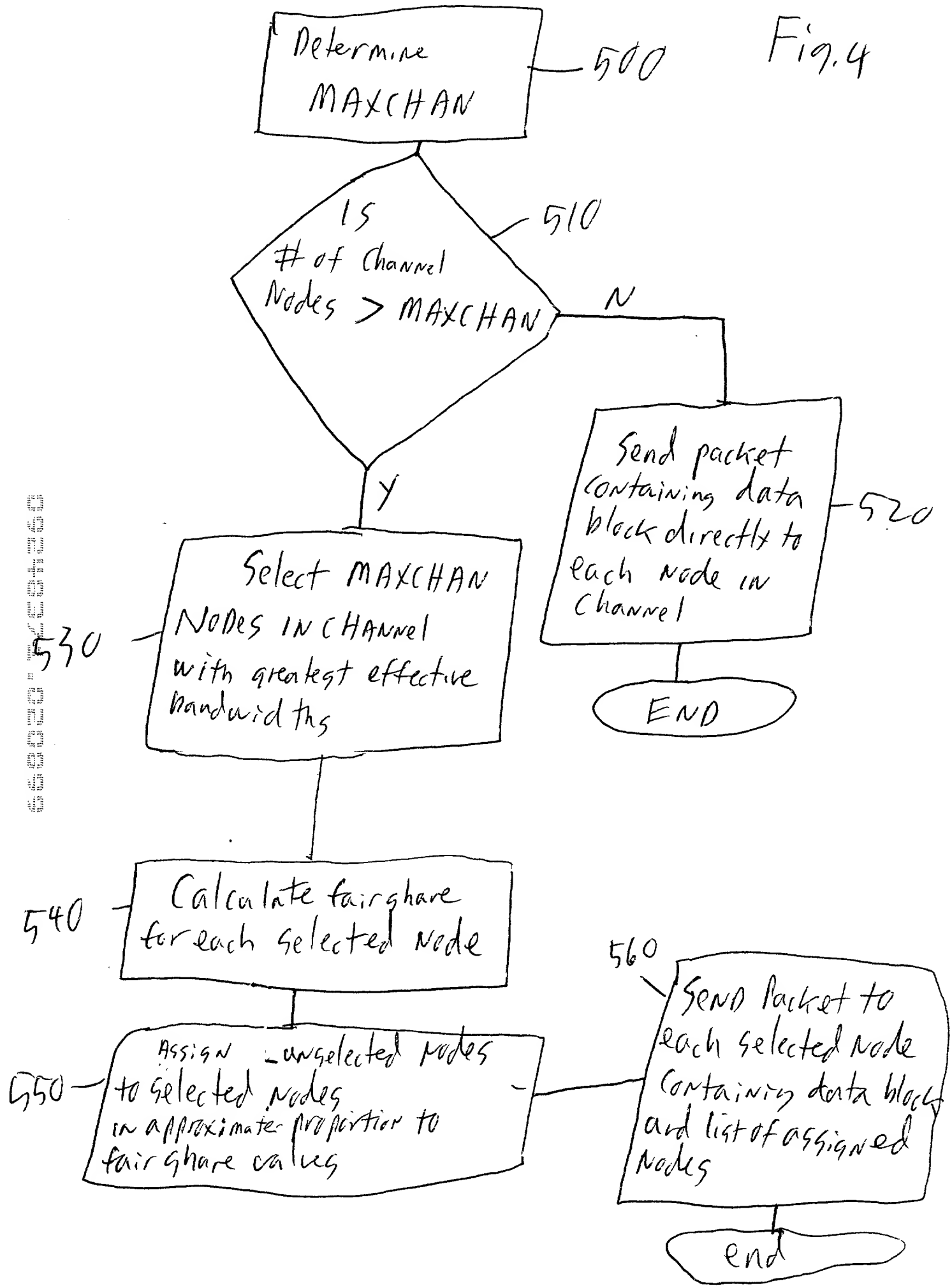

Determine MAXCHAN
500
Fig. 4
Is # of Channel Nodes > MAXCHAN
510
N
Y
Send packet containing data block directly to each node in Channel
520
END
Select MAXCHAN Nodes IN CHANNEL with greatest effective bandwidths
530
Calculate fairshare for each selected node
540
Assign unselected nodes to selected nodes in approximate proportion to fairshare values
550
560
Send Packet to each selected node containing data block and list of assigned Nodes
end

Figure 5

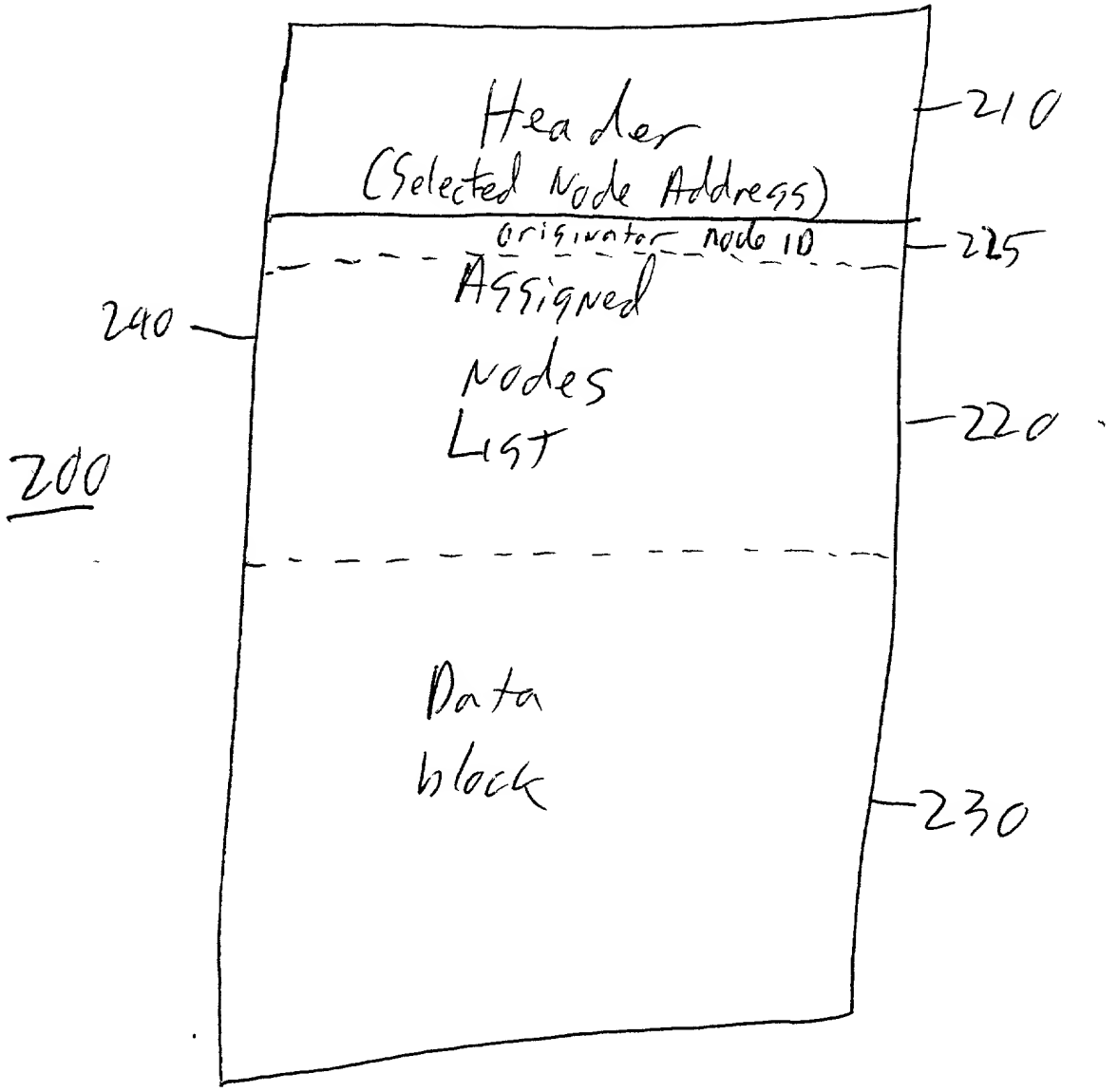
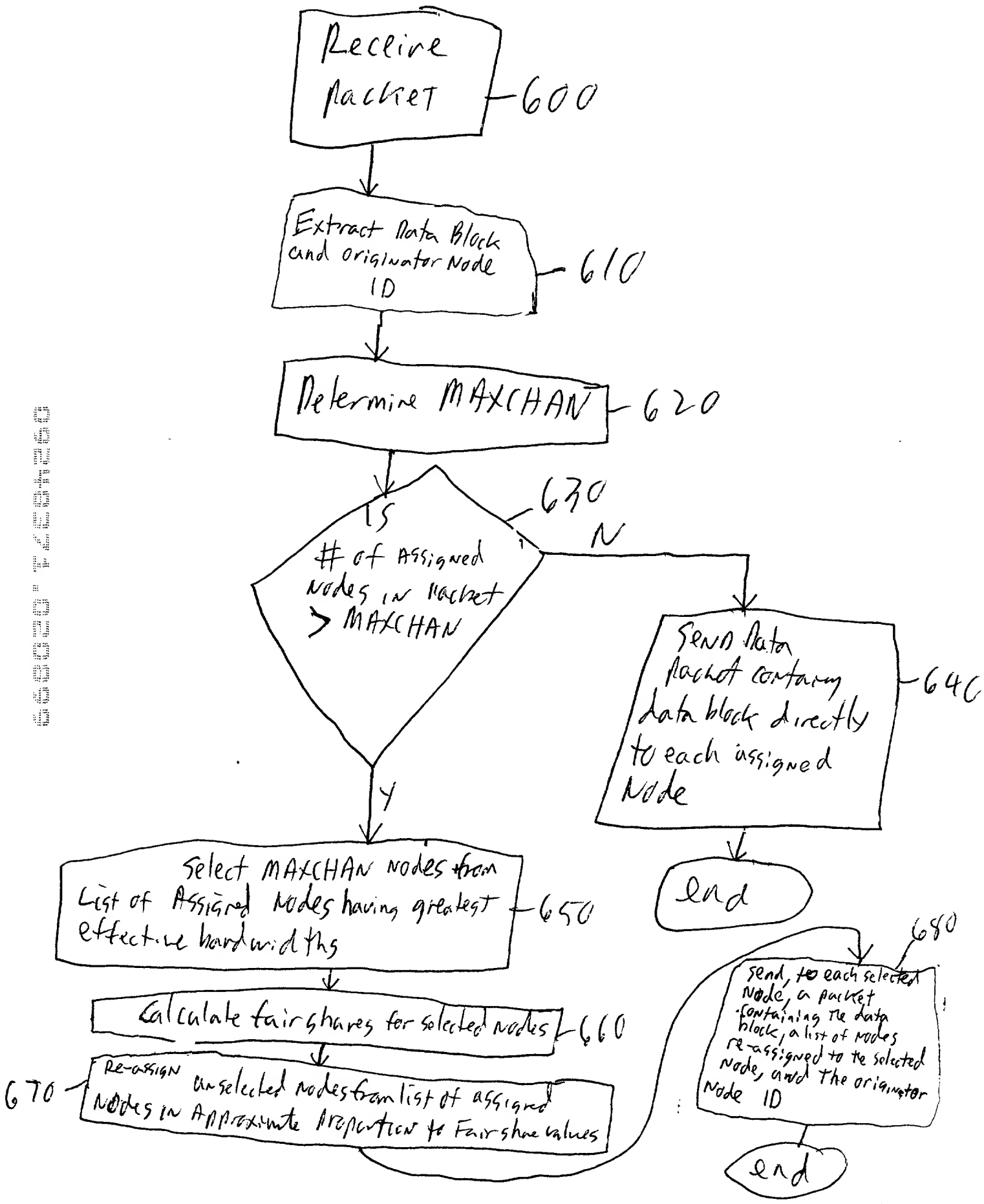

Header
(Selected Node Address)
210
originator node ID
225
240
Assigned
Nodes
List
220
200
Data
block
230

Figure 6


Receive Packet
600
Extract Data Block and Originator Node ID
610
Determine MAXCHAN
620
630
# of Assigned Nodes in Packet > MAXCHAN
Y
N
640
Send Data Packet containing data block directly to each assigned Node
End
Select MAXCHAN Nodes from List of Assigned Nodes having greatest effective bandwidths
650
Calculate fair shares for selected Nodes
660
670
Re-assign unselected Nodes from list of assigned Nodes in Approximate Proportion to Fair share values
680
Send, to each selected Node, a packet containing the data block, a list of Nodes re-assigned to the selected Node, and the originator Node ID
End

PATENT
ATTORNEY DOCKET NO: 10525/003001

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled EFFICIENT TRANSMISSION OF DATA TO MULTIPLE NETWORK NODES, the specification of which

- ■ is attached hereto.
- ☐ was filed on _____ as Application Serial No. _____ and was amended on _____.
- ☐ was described and claimed in PCT International Application No. _____ filed on _____ and as amended under PCT Article 19 on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby appoint the following attorneys and/or agents to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Eric L. Prahl, Reg. No. 32,590

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

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